



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

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|----------------------|-------------|
| Predmet: | Trdna snov |
| Course title: | Solid state |

| Študijski program in stopnja Study programme and level | Študijska smer Study field | Letnik Academic year | Semester Semester |
|---|-------------------------------|----------------------------|----------------------|
| Fizika 1. st. | | 3 | 5 |
| Physics 1st cycle | | 3 | 5 |

Vrsta predmeta / Course type

Univerzitetna koda predmeta / University course code:

| Predavanja Lectures | Seminar Seminar | Vaje Tutorial | Klinične vaje work | Druge oblike študija | Samost. delo Individ. work | ECTS |
|------------------------|--------------------|------------------|-----------------------|-------------------------|----------------------------------|------|
| 45 | | 30 | | | 105 | 6 |

Nosilec predmeta / Lecturer:

Jeziki / Languages:

| | |
|-------------------------------|---------------------|
| Predavanja / Lectures: | slovenski/Slovenian |
| Vaje / Tutorial: | slovenski/Slovenian |

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Pogojev ni.

Priporočljiva znanja so:
predznanje iz klasične in moderne fizike.

Prerequisites:

None.

Recommended is preknowledge of classical and modern physics.

Vsebina:

Content (Syllabus outline):

- Osnove kristalografije, Bravaisova in recipročna mreža.
- Mrežna nihanja: harmonski približek, specifična toplota trdnih teles, anharmonični pojavi (termično raztezanje, toplotna prevodnost).
- Kolektivni pojavi: dielektrične lastnosti dielektrikov, paraelektriki, feroelektriki, antiferoelektriki, paramagnetizem, feromagnetizem. Landauova teorija faznih prehodov, metoda molekularnega polja.

- Basics of crystallography, Bravais lattices.
- Lattice oscillations: harmonic approximation, specific heat of solids, anharmonic effects (thermal expansion, heat conductivity)
- Collective phenomena: dielectric, paraelectric, ferroelectric, diamagnetic, paramagnetic, ferromagnetic behaviour. Landau theory of phase transitions, mean field approximation.

Temeljni literatura in viri / Readings:

1. N.W. Ashcroft, N.D. Mermin, Solid state physics, (Rinehart and Winston, New York, 1976 in kasnejše izdaje).
2. M. P. Marder, Condensed Matter Physics, John Wiley & Sons, New York 2000.
3. C. Kittel, A. Zettl, Introduction to Solid State Physics, John Wiley & Sons, New York 2004.
4. <http://solidstate.physics.sunysb.edu/teach/intlearn/>
5. <http://www.ruph.cornell.edu/sss/sss.html>
6. <http://solidstate.physics.sunysb.edu/book/>

Cilji in kompetence:

Študenti usvojijo temeljna teoretična znanja s področja trdne snovi in jih znajo uporabiti pri reševanju ustreznih problemov z rabo matematičnih orodij.

Objectives and competences:

Students acquire basic theoretical knowledge in solid state physics and are able to use the knowledge to solve problems with the use of mathematical tools.

Predvideni študijski rezultati:

Znanje in razumevanje:

Po uspešno zaključeni učni enoti bodo študenti zmožni:

- uporabiti osnovne enačbe v trdni snovi za demonstracijo osnovnih električnih in termodinamskih lastnosti sistemov;
- opisati osnovne lastnosti kristalov;
- napovedati kvalitativne lastnosti sistema v odvisnosti od simetrije sistema.

Prenesljive/ključne spretnosti in drugi atributi:

Razumevanje procesov v trdni snovi je osnova za razumevanje procesov v fiziki materialov (tehnična aplikacija), mehki snovi in biofiziki.

Intended learning outcomes:

Knowledge and Understanding:

On completion of this course students will be able to:

- use basic equations of solids state physics to demonstrate basic electrical and thermodynamic properties of crystals;
- describe basic properties of crystals;
- description of qualitative behaviour of system as a function of symmetry.

Transferable/Key Skills and other attributes:

Understanding of processes in solid state is the basic knowledge necessary to understand processes in physics of materials (technical application), soft matter and biophysics.

Metode poučevanja in učenja:

Learning and teaching methods:

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|--|--|
| <p>predavanja in eksperimentalna predavanja (teoretičen uvod v problematiko z razlago in razgovorom, numerično reševanje posameznih problemov, demonstracijski poskusi pri predavanjih) teoretične vaje (delo s tekstom, metoda pisnih in grafičnih del, uporaba simulacij)</p> <p>elementi obrnjenega poučevanja</p> <p>Poučevanje in učenje potekata z didaktično uporabo informacijsko-komunikacijske tehnologije</p> | <p>lectures and experimental lectures (theoretical introduction by explanation and discussion, numerical solving of specific problems, demonstration experiments during lectures)</p> <p>theoretical exercises (work with text, work with graphic elements, use of simulations)</p> <p>elements of flipped learning</p> <p>Teaching and learning are done through the didactic use of ICT.</p> |
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| Načini ocenjevanja: | Delež (v %) / Weight (in %) | Assessment: |
|--|--------------------------------|--|
| Pisni izpit (lahko se nadomesti z dvema pisnima kolokvijema).. Ustni izpit. | 50 50 | Written exam (can be replaced by two written tests). Oral exam. |
| Za uspešno zaključeno učno enoto mora vsak del posebej biti pozitiven | | For a successfully finished course, both oral and written exams have to be positive. |

Reference nosilca / Lecturer's references:

- HÖLBL, Arbresha, MESAREC, Luka, POLANŠEK, Juš, IGLIČ, Aleš, KRALJ, Samo. Stable assemblies of topological defects in nematic orientational order. *ACS omega*. 2023, vol. 8, iss. 1, str. 169-179, ilustr. ISSN 2470-1343. DOI: [10.1021/acsomega.2c07174](https://doi.org/10.1021/acsomega.2c07174). [COBISS.SI-ID [137430275](#)]
- DOBOVIŠEK, Andrej, AMBROŽIČ, Milan, KUTNJAK, Zdravko, KRALJ, Samo. Liquid crystal based active electrocaloric regenerator. *Heliyon*. Mar. 2023, vol 9, iss. 3, [article no.] e14035, str. 1-12, ilustr. ISSN 2405-8440. <https://www.sciencedirect.com/science/article/pii/S2405844023012422?via%3Dihub>, DOI: [10.1016/j.heliyon.2023.e14035](https://doi.org/10.1016/j.heliyon.2023.e14035). [COBISS.SI-ID [143422211](#)]
- PAL, Kaushik, ASTHANA, Nidhi, ALJABALI, Alaa AA, BHARDWAJ, Sheetal K., KRALJ, Samo, PENKOVA, Anastasia, THOMAS, Sabu, ZAHEER, Tean, SOUZA, Fernando Gomes de. A critical review on multifunctional smart materials "nanographene" emerging avenue : nano-imaging and biosensor applications. *Critical reviews in solid state and materials sciences*. 2022, vol. 47, no. 5, str. 691-707, ilustr. ISSN 1040-8436. DOI: [10.1080/10408436.2021.1935717](https://doi.org/10.1080/10408436.2021.1935717). [COBISS.SI-ID [68095491](#)]
- MESAREC, Luka, IGLIČ, Aleš, KRALJ, Samo. Spatial manipulation of topological defects in nematic shells. *The European physical journal. E, Soft matter*. Jul. 2022, iss. 7, art. no. 62, 1-7 str., ilustr. ISSN 1292-8941. <https://link.springer.com/article/10.1140/epje/s10189-022-00216-z>, DOI: [10.1140/epje/s10189-022-00216-z](https://doi.org/10.1140/epje/s10189-022-00216-z). [COBISS.SI-ID [117006851](#)]
- HARKAI, Saša, KRALJ, Samo. Structural transformations of nematic disclinations. *The European physical journal. E, Soft matter*. Sep. 2022, vol. 45, iss. 9, 8 str. ISSN 1292-8941. DOI: [10.1140/epje/s10189-022-00226-x](https://doi.org/10.1140/epje/s10189-022-00226-x). [COBISS.SI-ID [136110339](#)]